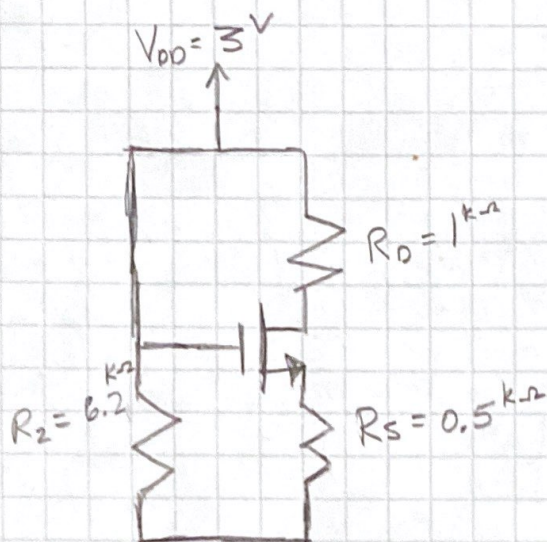


Hand Calculations



$$k'_n = 1.825 \text{ mA/V}^2 \left(\frac{W}{L}\right) = 1$$

$$V_{TN} = 1$$

$$V_G = V_{DD} = 3V$$

$$V_S = V_G - V_{GS}$$

$$I_D = \frac{V_S}{R_S}$$

$$V_{DS} = V_{DD} - I_D(R_D + R_S)$$

$$V_{GS} > V_{TN}$$

$$V_{DS} > V_{GS} - V_{TN}$$

(assume saturation)

$$I_D = \frac{V_S}{R_S} = \frac{V_G - V_{GS}}{R_S} = \frac{1}{2} k'_n \left(\frac{W}{L}\right) (V_{GS} - V_{TN})^2$$

$$3V - V_{GS} = (1.825 \text{ mA/V}^2)(0.5 \text{ k}\Omega)(V_{GS} - 1)^2(0.5)$$

$$V_{GS} = \{-2.4591, \underline{2.2673}\}$$

$$I_{DQ} = \frac{V_G - V_{GS}}{R_S} = 1.4654 \text{ mA}$$

$$V_{DS} = V_{DD} - I_D(R_D + R_S) = 3V - 1.4654 \text{ mA}(1 \text{ k}\Omega + 0.5 \text{ k}\Omega) = 0.8019V$$

$$\underline{\text{not saturation}} \quad V_{DS} < V_{GS} - V_{TN}$$

$$Q\text{-point} = (I_{DQ}, V_{DSQ}, V_{GSQ}) = (1.465 \text{ mA}, 0.802V, 2.267V)$$

Linear: $V_{DS} = V_{DD} - I_D(R_D + R_S) = V_{DD} - \frac{V_G - V_{GS}}{R_S}(R_D + R_S)$

$$I_D = \frac{V_S}{R_S} = \frac{V_G - V_{GS}}{R_S} = K'_n \left(\frac{W}{L} \right) \left[(V_{GS} - V_{TN}) V_{DS} - \frac{V_{DS}^2}{2} \right]$$

~~$$\frac{3^V - V_{GS}}{0.5 \text{ k}\Omega} = (1.825 \text{ mA/V}^2) (V_{GS} - 1) \left[3^V - \frac{3^V - V_{GS}}{0.5 \text{ k}\Omega} (1.5 \text{ k}\Omega) \right] -$$~~

$$V_G = 3$$

$$K = 1.825 \text{ mA}$$

$$V_{DD}$$

$$\frac{V_G - V_{GS}}{R_S} = K'_n (V_{GS} - V_{TN}) \left[V_{DD} - \frac{V_G - V_{GS}}{R_S} (R_D + R_S) \right] - \left[V_{DD} - \frac{V_G - V_{GS}}{R_S} (R_D + R_S) \right]^2$$

$$\frac{3^V - V_{GS}}{0.5 \text{ k}\Omega} = (1.825 \text{ mA/V}^2) (V_{GS} - 1) \left[3^V - \frac{3^V - V_{GS}}{0.5 \text{ k}\Omega} (1.5 \text{ k}\Omega) \right] - \left[3^V - \frac{3^V - V_{GS}}{0.5 \text{ k}\Omega} (1.5 \text{ k}\Omega) \right]^2$$

$$V_{GS} = \{ \underline{2.3007^V}, 4.4299^V \}$$

$$I_{DQ} = \frac{V_G - V_{GS}}{R_S} = \frac{3^V - 2.3007^V}{0.5 \text{ k}\Omega} = 1.3986 \text{ mA}$$

$$V_{DS} = V_{DD} - I_D(R_D + R_S) = 3^V - (1.3986 \text{ mA})(1.5 \text{ k}\Omega) = 0.9021^V$$

$$Q \text{ point} = (1.399 \text{ mA}, 0.902^V, 2.301^V)$$